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UNCLASSIFIED INFORMATION ON SOVIET BLOC INTERNATIONAL GEOPHYSICAL COOPERATION - 1960

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INFORMATION ON INTERNATIONAL GEOPHYSICAL COOPERATION

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I. GENERAL

Soviets Establish Popular Observatories

An Izvestiya article of 16 March reports that the great advances made in space research in recent years, together with the accompanying publicity, have whetted the enthusiasm of the everyday citizen for facilities to observe phenomena in space. Accordingly, the authorities have responded by establishing popular observatories. On 15 March such a facility opened its doors in Moscow in the Stalin Park of Culture and Rest. It houses a powerful Zeiss refracting telescope. Other popular observatories will be established in the Gor'kiy, Sokol'nik, and other parks in the capital. ("Popular Observatories," Izvestiya, 16 March 1960, page 6)

II. ROCKETS AND ARTIFICIAL EARTH SATELLITES

Lutskiy Answers the Question: "Where is the Soviet Satellite of the Sun?"

A letter to the editor in a recent issue of Sovetskaya Aviatsiya asks the question: "Where is the Soviet Satellite of the Sun Now?" The question, asked by a Captain N. Petushkov, is answered by V. Lutskiy, an official at the Moscow Planetarium, in the following manner:

> "For fourteen months a new satellite has been moving around the Sun -- a 'new inhabitant' created by the labor of the Soviet people. It will soon complete its first revolution around the Sun."
>
> "According to the flight schedule the first cosmic rocket passed near the Moon at 1700 hours on 3 January 1959; after moving away from it, it entered its eternal elliptical orbit as an artificial satellite of the Sun."

"From that moment the attraction of the Earth no longer exercised any notable influence on its flight. The Sun, the dynamic center of the entire solar system, became the basic center of attraction."

"Twelve days after launching--on 14 January--the rocket reached perihelion, that is, it arrived at the point nearest the Sun--146.4 million kilometers away. At that moment the velocity of its motion was the greatest--32.5 km per second."

"In the initial part of its route the new satellite of the Sun somewhat outstripped the Earth in its motion, but on 27 April 1959 our planet 'overtook' the satellite. At that time the two were separated by about 18 million kilometers. Then the Earth, which is moving closer to the Sun, began to increasingly outrun the rocket."

"On about 1 September the new planet was at aphelion--at its greatest distance from the Sun--197.2 million kilometers away. It had then traveled more than 500 million kilometers and covered exactly half of its route around the Sun, taking a total of 15 months. Its velocity at that time was at its maximum--23.9 km per second."

"Now the velocity of the satellite is increasing again. It can be seen from the sketch (not reproduced here) that it is now approaching the point of its entry into orbit, which it will reach in the month of April. At the beginning of March the Earth will be situated at a distance of over 200 million kilometers from the Sun's new satellite."

"Due to the fact that the periods of the Earth's revolution and that of the artificial planet do not coincide, the two heavenly bodies will rarely approach one another; this will occur only in January of the years 1975, 2028, and 2044. In 15 years the new planet will lag in orbit behind the Earth by 6 days, in 68 years it will be 3 days ahead, and in 84 years it will again lag by 3 days. But even at the time of such rather close meetings the distance between the two will amount to several million kilometers." ("Where is the Soviet Satellite of the Sun Now?", by V. Lutskiy, Sovetskaya Aviatsiya, 4 March 1960, page 4)

Rocket Measurements of the Earth's Magnetic Field

One of the objectives of the geomagnetic measurements made by the cosmic rocket launched on 2 January 1959 was the collection of experimental data on the intensity of the Earth's magnetic field at distances of several earth radii from the Earth's center. Such data are extremely necessary for checking the presently existing theory of magnetic storms and auroras.

Present-day theories assume the possibility of the formation of electric currents flowing around the Earth during magnetic storms; some theories indicate they are at distances of several earth radii, others, at distances of several dozen earth radii. It is assumed that those currents are created during the movement of charged particles ejected from the Sun and captured by the Earth's magnetic field. The magnetic field of such currents can be noted by magnetic measurements in a rocket from the change in character of decrease of the magnetic field with height.

Measurements on the rocket were made with a 3-component magnetometer with data units of the magnetically saturated type.

Figure 1 is a graph showing the change in the Earth's magnetic field in relation to distance from the Earth. Curve 1 indicates the field measured by the magnetometer, curve 2--the computed values for the field, curve 3--the difference between the computed and measured values of the field.

A comparison of measured and computed values of the field shows that in the sector of rocket flight from $14.7 \cdot 10^3$ to $30 \cdot 10^3$ km the measured values substantially differ from the computed values.

The authors remind us that relative and absolute errors in measurement at distances of 5-6 earth radii increase due to a number of reasons.

It may be regarded as established, they state, that the magnetic field at distances of 2-5 earth radii is not only determined by values computed from the Earth's magnetic potential, but also depends on external causes.

The explanation for the anomalous effects in the distribution of the magnetic field must be sought in the magnetic phenomena arising during the movement of charged particles in the Earth's magnetic field.

Figure 2 is a graph of the intensity of corpuscular radiation and the anomalous part of the magnetic field in relation to distance from the Earth.

The results of measurement of the intensity of corpuscular radiation in a cosmic rocket, using a scintillation counter, are shown in curves 2 and 3 of Figure 2 (curve 1 is the difference between the computed and measured values of the magnetic field). The change in corpuscular radiation recorded by the Geiger-Muller counter in the Pioneer III rocket is shown also, in curve 4 during departure from the Earth, and in curve 5 during its return.

A joint examination of the data for measurements of field intensity and the intensity of corpuscular radiation leave no doubt that the effects observed in the magnetic field are associated with the corpuscular zone and are the result of the super-position on the Earth's magnetic field of the magnetic field of the corpuscular zone.

One of the most probable causes of the magnetism of the corpuscular zone may be the currents arising due to the drifting of particles in the

Earth's nonhomogeneous magnetic field. These currents may flow along geomagnetic parallels from east to west.

It is also apparent that the intensity and structure of the anomalous part of the magnetic field will change depending on solar activity and the degree of magnetic disturbance.

These magnetic measurements on the cosmic rocket give evidence supporting the theory that assumes the existence of external sources of the magnetic field at a distance of several radii from the center of the Earth.

The establishment of qualitative relationships between the discovered magnetic effects and parameters of the outer corpuscular zone is a very important theoretical and experimental objective. ("Results of the Measurement of the Earth's Magnetic Field in a Cosmic Rocket," by S. Sh. Dolginov and N. V. Pushkov, Doklady Akademii Nauk SSSR, Vol. 129, No. 1, 1959, pages 77-80)

III. UPPER ATMOSPHERE

Pravda Reviews Investigation of the Earth's Belts of Radiation

The following is the full text of a feature article in Pravda of 23 March 1960.

The work of a group of scientists has been proposed for consideration for the award of a Lenin Prize. This work, by S. N. Vernov, A. Ye. Chudakov, V. I. Krasovskiy, I. S. Shklovskiy and Sh. Sh. Dolginov, is entitled "Investigation of Cosmic Radiation and the Magnetic Field of the Earth and Moon." Their research, accomplished by using instruments carried into space on the artificial earth satellites and cosmic rockets, has led to the discovery of the so-called radiation belts of the Earth. We have found that the Earth is surrounded by a sort of aureole or cloud of charged particles of high energies, held by its magnetic field. This cloud is clearly divided into two belts—inner and outer.

The equatorial diameter of the outer belt is about a hundred thousand kilometers. Within it there is a gap with a diameter of about 40,000 km. The belt is symmetrical in respect to the Earth's magnetic axis and its meridional cross section has the form of a sickle with narrowing points whose ends reach the upper layers of the atmosphere at geomagnetic latitudes of 50-60°.

The inner belt is situated in the gap of the outer belt. It extends 40 degrees in latitude on both sides of the geomagnetic equator; in height it extends from several hundred to five or six thousand kilometers above the Earth's surface.

The belts differ in the nature of the particles making them up: in the outer belt the instruments register electrons with energies in the tens and hundreds of thousands of electron volts, while in the inner belt--protons with energy of tens and even hundreds of millions of electron volts.

To Soviet scientists goes the priority in discovery of the outer belt, and a substantial role in investigation of the inner belt.

The first signs of the existence of the outer belt were noted during the flight of the second Soviet aritifical earth satellite, launched on 3 November 1957. During the flights of the satellite at high geographic latitudes flares were discovered of a radiation intensity not susceptible of recording by ground instruments. These results were then confirmed by observations on the third Soviet artificial earth satellite, launched on 15 May 1958.

On the third satellite there was a so-called "luminescent counter." It effectively recorded not only high-energy particles, but also electrons of relatively low energies, and also determined the total ionization created by all the particles entering the instrument.

The basic result stemming from the third satellite was the discovery and investigation of the outer belt of radiation. From observations of approximately 300 cases of flight over the territory of the Soviet Union there was discovered an inclined boundary surface; on intersecting it in the direction equator-pole, the satellite enters a zone filled with electrons of relatively low energies--tens or hundreds of thousands of electron volts. The departure of the satellite from the electron zone into the particle-free space around the Pole was also observed repreatedly during flights over Antarctic stations. The discovery of particle-free zones at the Poles is of importance for astronavigation because it makes it possible for future space ships to leave the Earth, bypassing the radiation at the two poles that is dangerous for living organisms.

The discovery of the high-latitude zone served as evidence of the existence of the inner belt and the presence of a gap therein. Simultaneously with the conduct of observations on the third Soviet satellite, the hypothesis was proposed that the charged particles of the radiation belt were, so to speak, "locked" in the Earth's magnetic field and fluctuate along magnetic lines of force; they are supplemented by neutron decay and possibly by the capture of solar corpuscles.

The inner belt was first discovered by the American scientist Van Allen and his associates and was based on data relative to charged particles provided by counters installed in the first and third American satellites launched on 31 January and 26 March 1958 respectively. These counters do not differ substantially from those used on the second Soviet satellite, but they operated with protracted interruptions; those interruptions may have been the result of malfunction of the apparatus or the exceptionally high intensity of the measured radiation.

The newly discovered Van Allen radiation was not and could not be considered a "belt" at that time. To so consider it, it was necessary not only to discover a high intensity of cosmic rays over the equator, but also its absence in the middle latitudes. And Van Allen could not do this, because the American satellites did not reach latitudes greater than 35°, that is, they did not go beyond the limits of the inner belt. Only the results of measurements on the third Soviet satellite launched on 15 May 1958, made it possible to determine the boundaries of the inner belt, estimate the energy of the particles constituting it, and also discover longitudinal assymetry therein caused by the fact that the Earth's magnetic axis does not pass through its center.

The next important stage in investigation of radiation belts was the flights of cosmic rockets. The Soviet cosmic rockets carried apparatus that accomplished a still wider range of measurements than on the third satellite. By means of this apparatus we succeeded in getting various radiation characteristics for the outer radiation belt. The distribution of particles by energy was determined and their nature was established. The cosmic rockets enabled us for the first time to investigate cosmic radiation in interplanetary space outside the Earth's magnetic field and determine its composition.

Closely associated with the study of the radiation belts is the investigation of the Earth's magnetic field. The instruments carried by the cosmic rockets enabled us to discover a considerable difference in the actual magnetic field of the Earth and the computed one. This is due to the presence of strong electrical currents at distances of tens of thousands of kilometers from the center of the Earth, that is, far beyond the limits of the ionosphere, but within the radiation belts. Of special interest is the minimum intensity of the magnetic field at a distance of 20,000 kilometers from the center of the Earth, discovered during the flight of the first cosmic rocket.

By means of cosmic rockets it has been established that the Moon has no noticeable magnetic field and belts of radiation, that is, charged particles held in a magnetic field.

Until now we have no theory of terrestrial magnetism. The practical absence of a magnetic field on the Moon gives us reason to conjecture that the strong magnetic field of the Earth is caused by its relatively rapid rotation.

The scientific work of the Soviet space researchers is significantly expanding our knowledge of the cosmic space surrounding us and is undoubtedly meritorious of the Lenin Prize. ("Belts of the Earth," by Professor A. Lebedinskiy, Pravda, 23 March 1960, page 6)

Mass-Spectroscopic Measurement of the Ion State of the Upper Atmosphere

The radio frequency mass-spectrometer carried by the third Soviet artificial earth satellite is described in considerable detail by V. G. Istomin in issue 3 (1959) of the Academy of Sciences series Iskusstvennyye sputniki zemli.

During the period 15 through 25 May 1958 about 15,000 mass spectra were recorded at heights between 225 and 980 km. The measurements were made in the Northern Hemisphere between latitudes 27° and 65°. The data received on the state of the ionosphere on all the revolutions of the satellite about the Earth have provided us with complex altitudinal-latitudinal cross sections of the atmosphere. This makes more complicated the interpretation of the results, making difficult the derivation of purely latitudinal or purely latitudinal relationships.

Figure 1 reproduces four photograms showing a great number of peaks and low resolution, especially in the field of large mass numbers. This article is devoted almost entirely to an interpretation of these peaks. ("Mass-Spectroscopic Measurements of the Ion State of the Upper Atmosphere on the Third Artificial Earth Satellite," by V. G. Istomin, Doklady Akademii Nauk SSSR, Vol. 129, No. 1, pages 81-84)

Research Continues on the Azerbaydzhan Meteorite

The large meteorite which landed near the Azerbaydzhan village of Yardymly on 24 November 1959 continues to be the subject of intense study. The remnants consist of five fragments ranging in weight from 360 grams to 127 kilograms. It has an iron content of 92.7%, nickel 6.6%, cobalt 0.41% and phosphorus 0.18%, and contains other elements in insignificant quantities.

The article reminds us that no element has been discovered in a meteorite that has not already been known on Earth, although minerals have been found in meteorites that are otherwise unknown on our planet. Under the influence of cosmic particles new, so-called cosmogenic isotopes of many chemical elements are formed.

Three cosmogenic isotopes of the Yardymly meteorite are being studied at the Institute of Geochemistry and Analytical Chemistry and at the Radium Institute of the Academy of Sciences of the USSR. At the request of foreign scientists samples of this meteorite have been sent to the United States and Switzerland for study. Such cooperation will permit us to get fuller and more precise results and enhance scientific contact between Soviet and foreign scientists. ("Messenger from Space," by Ye. Krinov, Promyshlenno-Ekonomicheskaya Gazeta, 23 March 1960, page 4)

"Flight Into the Cosmos"

Following is a translation of an article by A. A. Shternfel'd, Winner of the International Prize for Encouraging Work in Astronautics, subtitled, "Results of Studies of the Atmosphere and Outer Space Made with Artificial Satellites and Rockets."

The numerous studies made in recent years on the atmosphere and outer space by means of high-altitude rockets and artificial satellites are not only of great scientific importance but also bring nearer the day when man will fly into outer space. Let's have a look at the results of these studies.

Structural Characteristics of the Atmosphere

In taking off into outer space a space rocket must pass through the atmospheric shell which encloses the earth. For this reason we must have exact information on the structural and electric properties of the atmosphere, especially the upper layers.

The composition and density of the air are of prime importance in determining the heating to which space apparatus is subject. The predominant component of the upper layers of the atmosphere (at heights of 230-950 kilometers) are the ions of atomic oxygen. There are considerably fewer nitrogen atoms; one ion of nitrogen to each 15-30 ions of atomic oxygen. On the basis of data provided by the satellites and rockets it has been established that at an altitude of approximately 225 kilometers the density of the air reaches 3/10,000 of a milligram per cubic meter and at an altitude of 360 kilometers from 100-120 billionths of the density at sea level. Thus the density of air at altitudes above 200-300 kilometers is 10 times greater than was originally believed to be true.

When we take this new data into account we find that the orbits of artificial satellites (especially the perigee) must be raised to a great height in order to escape the undesirable resistance of the air during their gliding. We must also point out that the density of the atmosphere has considerable effect on the speed of particle streams and meteoric bodies which enter the atmosphere, as well as on the process of their decay during flight.

Measurements of the temperature of the atmosphere made during the passage of a satellite through its perigee (at an altitude of approximately 225 kilometers) indicate that it is considerably greater than formerly believed. Hence as a consequence of the extreme rarity of the atmosphere along the tracking course of the satellites its temperature has practically no effect on the equivalent temperature of the satellite itself.

We must also point out that the temperature of the third Soviet artificial satellite is regulated by means of louvers by turning the rotating slats at a certain angle to the sun's radiation. Thus the temperature inside the satellite equals 15-22°C. This is room temperature, and is quite favorable for future astronauts. /Note: Quite valuable data were obtained from the second and third space rockets with regard to the temperature inside the container. As mentioned, the temperature of the gas in the hermetically sealed environment was maintained at 20-25°C in the second space rocket and 25-30° in the third space rocket./

Electrical Characteristics of the Atmopshere and of Space Around the Earth

By means of the third Soviet satellite the magnetic field of the earth was measured at an altitude of from 230- to 1,800 kilometers. The greatest intensity of the magnetic field was found at a height of 500 kilometers. These data make it possible to calculate the intensity of the earth's magnetic field at different altitudes.

If there were no magnetic field around the earth, the speed of a satellite's rotation around its longitudinal axis in airless space would be constant. However its presence greatly reduces the speed. Moving along in the ionosphere the satellite acquires a negative potential which has been measured at various altitudes. At a height of 242 kilometers it equalled 7 volts and at 795 kilometers 6 volts. The intensity of the electrostatic field of the supper layers of the atmosphere was found to be 10-100 times greater than formerly believed.

Measurements of the electron concentration made with rockets during the past years did not confirm our assumptions as to the laminar composition of the ionosphere.

Studies on atmospheric ionization and the concentration of electrons in the ionosphere are of great importance for learning the conditions governing radio communication in general as well as the communication of space ships with the earth in particular.

As we have seen, the refraction of light in the atmosphere has considerable influence on our observations of artificial satellites and on our determination of their orbits. Besides the refraction of radio waves is greater when they pass through the ionosphere. As a result radio signals from the satellite can be received before the satellite itself becomes visible on the horizon and recorded after it has passed from sight. These phenomena of "radio dawn" and "radio twilight," which significantly prolong radio signal reception beyond visual observation, were detected in studying the conditions governing radio communications with the first Soviet artificial satellites on wavelengths of 7.5 and 15 meters. The "premature" radio dawn may also be due to other causes, as for example, the repeated reflection of radio waves from two ionized layers.

A year after the launching of the third Soviet artificial satellite its "Mayak" radio transmitter, which transmitter close to 100,000 radio bearings during this time, was still working faithfully, despite the fact that the solar transistor battery which powers it had been almost constantly "bombarded" by streams of micrometeorites. Its chemical sources of power were also working.

The radio apparatus installed in the second space rocket operated in an excellent manner; it functioned continuously during its entire course from the earth to the moon.

All this gives us reason to expect that future crews of artificial satellites and interplanetary rockets will be able to maintain constant communication with the earth.

The Meteor Hazard and Harmful Radiation

From data obtained from the third Soviet artificial satellite we find that on an average only 1 gram of meteoric matter will strike each square meter of the surface of a space ship during the course of more than 300 years. But the distribution of meteoric bodies is very nonhomogeneous. An artificial satellite has passed at times through peculiar meteor streams. Then the number of meteorite impacts reached 10 or more per second per square meter. However the cover of the satellite remained intact. For this reason the meteor hazard must not be considered so menacing as was once believed before the lauching of the satellites.

Less pleasant are the results of observations of cosmic radiation which at a height of approximately a thousand kilometers was unexpectedly intense. It greatly exceeds the maximum radiation dose permissible for the human body. This indicates the necessity for more reliable screening of astronauts in space ships.

Inasmuch as metal plating makes the space ships very heavy, designers of such vehicles are faced with complex problems.

Artificial satellites and space rockets revealed new intense radiation around the earth located in two belts. As shown by these studies, as we leave the earth this radiation increases hundreds of times in intensity and reaches its maximum at a height of three of the earth's radii. This belt is called the inner zone. Then the radiation diminished sharply and at a distance of 60,000 kilometers or more from the center of the earth remains practically constant. At geomagnetic latitudes exceeding 65 degrees it suddenly drops and is practically nonexistent in the polar zone. This belt is called the outer zone.

The first space rocket which revealed the existence of intense radiation passed too quickly through this danger zone for the data which it obtained to be able to delineate the characteristics of this new phenomenon. For this reason the second space rocket was provided with apparatus for additional studies of the radiation belts around the earth.

Anologous studies were made in the United States. Their results confirm the information obtained by Soviet scientists.

As we can expect from ours and the American data, it will be difficult for man to pass through the barrier of intense radiation which exists near the earth but if it is encountered in interplanetary flight even the comparatively thin shell of the space ship will be sufficient protection against radiation sickness.

As for belts of harmful radiation around the moon the second place rocket did not detect any.

Along with the difficulties of space flight for future astronauts there are also favorable circumstances. As has already been said, at the height of the first several hundred kilometers harmful radiation is not yet intense while the space rocket is only gathering speed and is moving comparatively slowly. They become dangerous only at a height of a thousand kilometers when the rocket is hurtling along with greater speed. Hence the most dangerous zone (the inner zone) will be crossed when the rocket is going very fast. With somewhat less but still very great speed the rocket will fly through the second (outer) zone which is less dangerous. Not until after leaving this zone will the rocket gradually reduce speed.

The flight course of interplanetary ships must be selected so that astronauts will be subject to the last possible harmful radiation. In this connection foreign scientists have proposed entering space in the polar regions where we have found the harmful radiation is practically nonexistent. On the other hand such flight is complicated by difficult weather conditions and the absence of great industrial centers in these regions. In addition the launching of rockets there involves the consumption of additional fuel. Inasmuch as the speed of rotation of the earth's crust in the polar regions is very small, it would be necessary to give up the free energy assistance of the earth which originates from its rotation around its axis. To these impediments we must add another. In July 1959 American scientists (Ney and others) discovered harmful radiation over the polar zones which had not been observed before.

The Physiology of Space Flight

For a number of years regular studies have been made in the Soviet Union on the vital functions of animals during flight in high-altitude rockets. For this purpose dogs and apparatus which automatically record the vital functions of the body have been sent up to a height of from 100 to 450 kilometers and more. In this enterprise the weight of the main load in 1959 reached close to 2 tons. During the fall of the rocket to earth the dogs were ejected by means of catapults. For flights at an altitude of 100 kilometers the dogs were fitted with special pressure suits and for flights at an altitude of 200 kilometers and over the animals were placed in sealed cabins. In order to regenerate the air in the cabins a special installation was fitted in with the dogs. The experiment showed that it worked satisfactorily. Air pressure during flight varied to an insignificant degree (from 775 to 790 millimeters Hg).

During the first 90 seconds the temperature of the outer shell of one of the rockets rose from 21 to 93 degrees and then gradually dropped. By the 226th second of flight it stood at 58 degrees. During this time the temperature of the insulating layer (8 millimeters of felt) fluctuated between 22 and 25°C and the air temperature in the cabin changed only one half of a degree.

When the motors were working the respiratory and pulse rate and blood pressure rose but did not go beyond the permissible norm. In nonanesthetized animals the effect of weightlessness during the initial stage caused temporary physiological disruption (no more than 3 minutes) after which it rapidly (within 2-3 minutes) returned to normal. When the animal was under anesthesia no deviations from the normal were observed. After the experiment the body temperature of some animals was up to 0.8 degree higher and of some up to 0.5 degree lower than normal. This indicates that the reactions of animals are different but that their temperature did not go beyond physiological norms.

Analyses of blood taken from dogs before and after flight showed fluctuations which did not exceed changes observed under normal conditions while preparing the animals for flight. But in some animals there was a marked increase in the number of leucocytes and this leucocytosis persisted for several days.

In some cases after landing the dogs showed insignificant hemorrhages (from the nose, near the anal opening, in the sclera of the eyes) but they did not lead to serious consequences. It is believed that these phenomena occurred during the descent when the parachute braking upon entry into the dense layers of the atmosphere is very intensive; in addition the body position of the animals which underwent various abrupt changes from the very start was far from optimal.

The launching of the second artificial satellite with an experimental animal (the dog Laika) in a specially outfitted sealed cabin revealed completely new possibilities for studying the adaptability of living organisms to acceleration and prolonged weightlessness. While the engine was working the contraction frequency of the heart muscles in Laika increased almost threefold but this dangerous period did not have catastrophic consequences due to its brevity (several minutes). When the engine stopped working the pulse rate gradually returned to normal. On the whole Laika's physiological condition was slowed down for several days.

The mechanical effect of such experiments on people would be uncertain. We must make many experiments before the first man flies into interplanetary space.

The effect of weightlessness on fliers has been studied during special figure flights which lasted from 30-45 seconds. Sensitivity to the physiological effect of weightlessness was found to be quite different not only in different individuals but even in the same person depending on the circumstances. Some individuals became more or less seriously ill while others withstood the loss of weight satisfactorily. This indicates the advantage of the possibility of selecting people resistant to space sickness, who are able to exist in a state of weightlessness without danger to health during more or less prolonged inertia flight.

Numerous laboratory studies have shown that the physiological reactions of persons during the ascent of a space rocket will not be a hindrance to actual flight. The results of experiments confirm that a four or five time increase in weight (as compared with the usual force of gravity on the earth), which acts for several minutes, can be withstood without consequence by the majority of persons. This is sufficient for reaching space speed.

To What Height Can Man Go Today?

We can imagine that we want to set a record for the height of rockets with man on board. In this instance we must take into account that the rocket must be analogous to the one which placed the third satellite in orbit. What ceiling can one reach under these conditions? Here it is necessary to take into consideration that there is as yet no possibility of making a parachute jump from a plane flying only one twentieth the speed of the artificial satellite. This same orbital rocket which placed the satellite in orbit takes off vertically. [Note: An orbital rocket is intended to achieve sufficient speed to go into a circular or elliptical orbit. Such a rocket may become an artificial earth satellite.] After reaching half its maximum speed the engine cuts out. The rocket contines its vertical flight through inertia, reaches its ceiling and starts to fall back to earth. As it descends the rocket continues to accelerate. If we disregard air resistance, at the height at which the engine cut out during the ascent the speed of fall equals the speed of ascent at the corresponding moment but their directions will be opposite. Let's assume that the vertical position of the rocket did not change during the entire time. Then in order to break its fall it would be enough to switch on the engine a second time and when the appropriate operating cycle was achieved the speed of fall would be completely reduced to zero at the moment when the rocket touched the earth's surface.

As we see, the pay load of the rocket which put into orbit the third Soviet satellite was more than 1.3 tons. This means that this rocket might lift a sealed cabin with one or two persons and all the equipment needed for a half year's flight. Calculations indicate that an orbital rocket used for lauching this satellite can develop in free space the so-called ideal speed (close to 9.1 kilometers per second) /Note: By free space we mean space in which there is no medium to cause resistance./

Let's assume that in its vertical take-off the rocket was given a boost of up to one-half the mentioned speed, or 4.55 kilometers per second and the rocket engine was so regulated that the flier was subject to 4 Gs. Were it not for the earth's gravity and air resistance the per second increase in speed of the rocket would be 39.2 meters per second (9.8 x 4). Under these conditions during rocket ascent the engine could work continuously for 116 seconds (4550:39.2). If we take into consideration that each second the earth's gravity alters the speed of the rocket 9.8 meters per second and during 116 seconds alters it 1140 meters per seond (9.8 x 116), we find that by the end of the engine's operation the speed of the rocket is 3410 meters per second. This speed is enough to lift the rocket to an additional height of 600 kilometers. We say "additional" because as shown by calculations when the engine stopped working the rocket was already at a height of 200 kilometers. Thus the rocket's ceiling would seem to be 800 kilometers. It is not difficult to compute that after the rocket's engine cuts off the rocket will continue to rise for approximately 6 minutes. Hence the ascent lasts a total of eight minutes.

If the rocket reaches a ceiling, it stops for a moment and then starts to fall back to the earth. What will its fall be like? There can be no doubt that the most economical would be a fall utilizing atmospheric resistance to brake the speed of the returning rocket. But this feature has not yet been technically solved. At the present stage we must apparently consume energy in order to slow down the rocket by turning on the engine.

In this case after a six-minute fall with an average speed of approximately 100 kilometers per minute the rocket is at a height of 200 kilometers, exactly the same height where 12 minutes before the engine was cut out. Now the engine is once more started but this time to inhibit the speed of the rocket which at this altitude reaches 3410 meters per second. Operating under the previous cycle for 2 minutes the rocket lands with a speed of zero. The entire flight lasts approximately 16 minutes.

If we reach a greater number of Gs while the engine is operating, we could reach a ceiling of more than 1000 kilometers.

What Distance Could Be Flown in a Quarter of a Year

We already know that the orbital rocket can be used to raise people to a height of from 800 to 1000 kilometers and over. With the aid of such a rocket the flier could make a leap in distance. In this case with the same operating cycle for the engine the rocket would take off at an angle of 40 degrees to the horizon and, as in the previous case, the engine would work for 2 minutes. As a result of the thrust obtained the rocket would rise in an elliptical arc to a height of 505 kilometers and then start to drop along with a symmetrical trajectory. During flight with the engine cut out the rocket would face about and at the same height at which the engine was cut out it would start again (this time to slow down the rocket). After 2 minutes the rocket with its pilot would land smoothly. The distance traveled would equal 2230 kilometers on the surface of the earth (the distance from Moscow to Omsk). The time for such a flight would be approximately 24 minutes. As in the previous case, the distance of flight can be considerably lengthened if we allow for greater number of Gs which the flier will undergo.

The imaginary experiment described we made with a composite rocket similar to the one which launched the third artificial satellite. If we assume that the weight of the gondola with the pilot reaches the weight of the first artificial planet (361 kilograms) and carry out flight with the aid of a space rocket which put it into a circular orbit, we will be able to reach almost double the height and speed. ("Flight Into the Cosmos," by A. A. Shterfel'd, Nauka i Zhittya, No. 2, 1960, pages 14-17)

Captions to Illustrations Accompanying
"Flight Into the Cosmos"

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IV. METEOROLOGY

Latest Report on the Pacific Ocean "Weather Ship"

The initial processing of the data of the first Pacific cruise of the expeditionary ship "A. I. Voyeykov" has been completed; the ship returned to Vladivostok a few days ago.

The chief of the expedition, the Director of the Far Eastern Scientific Research Hydrometeorological Institute, P. A. Uryvayev, in a conversation with a correspondent of Izvestiya reported:

"Over a period of one and a half months the 43 scientific workers of our Institute, the Central Aerological Observatory and the Academy of Sciences of the USSR conducted research in the northwestern part of the Pacific Ocean and in waters near the equator."

"We accomplished a wide range of hydrological, meteorological and aerological work. We made observations of the amount of heat passing from the atmosphere into the ocean and from the ocean into the atmosphere at different latitudes and at different times. Of considerable interest was the study of the distribution of air and wind velocity and direction from the ocean surface to high altitudes. This work was accomplished by using meteorological rockets. By using these rockets the scientists of the expedition were able to make a temperature-wind cross section from the middle latitudes to tropical latitudes."

"The 'weather ship' on the way to the equator and back twice passed through the zone of so-called jet streams in the atmosphere. Wind velocities were recorded there at great altitudes."

"The hydrologists of the expedition accomplished work in measuring currents in the ocean. New data were received on the North Equatorial Current and on one branch of the Kuroshio Current."

"Also of considerable interest are the observations that were made continuously over a period of several days of changes in the hydrological and hydrochemical properties of the waters of the ocean. We were able to collect new data on the regime of little-known internal waves in the open parts of the Pacific Ocean."

"The processed and scientifically analyzed data from this expedition will be published very soon."

"The research work of the expedition is of great theoretical and practical importance. It will be used for compiling long-range predictions, synoptic maps and the study of the laws of meteorological phenomena."

("Pacific Ocean Cruise of the 'Weather Ship'," Izvestiya, 11 March 1960, page 6)

Standard Production of Remote Control Meteorological Stations to Being in 1961

The following is a complete translation of a short notice appearing in a recent issue of a Soviet periodical.

Weather prediction--it is necessary to everyone--to the pilot of a vessel, to a collective farm worker, and to a city dweller planning a Sunday outing. Very interesting apparatus for use in determining weather conditions is annually being designed at the Scientific Research Institute of Hydrometeorological Instruments. Engineers there have recently developed a new remote control meteorological station for operational use. It is designed for servicing airdromes, hydrometeorological offices and weather stations.

"Our meteorological station," states the chief engineer M. Asbel', "enables us to get considerably more precise and detailed data about weather conditions than was the case before. In addition to the usual parameters--temperature, humidity and wind velocity--it determines the height of the lower limit of the cloud cover and the range of visibility. The new remote control meteorological station records many parameters on tape. It is equipped with a special recording device. The apparatus is serviced by one man."

Standard production of remote control meteorological stations for operational service will be inaugurated at the beginning of next year.

("Weather Predictions Will Be More Precise," Promyshlenno-Ekonomicheskaya Gazeta, 20 March 1960, page 4)

Meteorological Observatory on Mount El'brus Seeks to Induce Precipitation by Use of Sound

The following is a full translation of an article from the Soviet journal Promyshlenno-Ekonomicheskaya Gazeta.

Those persons who have visited in one of the most picturesque corners of the Central Caucasus--Baksanskiy Canyon--have noted a strange phenomenon. Soon after the sun drops behind the snowy peaks the slopes of the mountains become shrouded by a dense fog and the entire river valley is filled with a low, even, and monotonous sound. It appears that sounds, repeatedly reflected by the mountains, pour in from all sides. From time to time the sound is so loud that it is even stronger than the thunder of a powerful mountain stream.

This sound comes from special powerful generators that have been installed on one of the slopes of ancient Mount El'brus; there the workers of the El'brus High Mountain Complex Expedition of the Academy of Sciences of the USSR are conducting experiments on the influence of sound on clouds and fog.

The problem of controlling the weather, and especially the seeding of clouds and fogs, has attracted the attention of many scientists in recent times. It is planned to "intercept" the clouds and force them to liberate their moisture in precisely those places where the soil and crops are in special need of irrigation, or, instead, clear the sky over an airdrome or over a city, where, on a holiday, the sun should shine brightly. Is this feasible?

The first experiments in this direction conducted in the USSR and abroad gave extremely hopeful results. If a supercooled cloud, that is, a cloud having a temperature below zero, is sown with a substance such as dry ice or silver iodide, water will rapidly collect around the small microscopic ice crystals forming at this time. Then the drops, growing so heavy that the currents of rising air can no longer support them, fall to the earth. But this does not always happen although the experiments are frequently conducted under identical conditions. This is due to the fact that not all the laws of cloud development have been studied.

To all intents and purposes scientists have begun such work only in the last decade.

It is these laws that are being studied in the laboratory on the slopes of Mount El'brus. Experiments of El'brus are being conducted with clouds having a "plus" temperature; the methods used usually in supercooled clouds are little suited for clouds of this type. Therefore in this area it was decided to test a different method of influencing clouds and fogs--sound.

The scientists here are dealing with a phenomenon which each of us has probably observed more than once. Here is the way it goes. The entire sky is covered with dense black thunderclouds. Heavy, as if coated with lead, they hang above the earth; seemingly the rain is at the point of pouring down. But the rain does not come... Suddenly the lightning flashes, a deafening roll of thunder is heard and masses of water pour down after the peal of thunder.

Thunder is a powerful sound wave; it appears that this is a "reagent," a physical "catalyst" which can be used for causing precipitation.

It was not especially difficult to create clouds and fogs artificially in order initially to conduct experiments under laboratory conditions. It was more difficult to find an acoustic reagent to some degree resembling thunder. To do this the researchers first constructed a small but relatively powerful generator that emitted sound waves; these do not emit a single momentary impulse, but continuous impulses instead.

Experiments were conducted in a specially built chamber with a volume of 500 cubic meters. An artificially created fog is usually maintained therein for 1 to $1\frac{1}{2}$ hours. But scarcely are the sound generators activated and in literally one or two minutes it is completely dissipated.

The experiments were successful; the researchers then decided to conduct these experiments under natural conditions to test the method directly in the clouds.

A research laboratory has therefore now been organized near El'brus, where there are almost always clouds, and where dense fogs rise from the canyon up along the slopes in the evenings after sunset.

The scientific worker V. Vyal'tsev of the El'brus High Mountain Expedition designed powerful generators for use in the experiments; they have been installed on the slopes of the mountain. The generators are surprising not only in their size (their loudspeakers have a cross section as much as 9 square meters, but also in power--25 kilowatts each. At first glance these figures may not seem so large--after all, a small rural power station yields 25 kilowatts. But in this case we are speaking of sound volume.

Therefore when such a powerful beam of sound waves is directed at a cloud, the very smallest drops of water, scarcely visible even under strong magnification, come into a state of oscillatory movement. "Warm" clouds and fogs are made up of such particles. These drops collide with one another with ever-increasing frequency, fuse together on collision, grow in size, increase in weight, and drop downward.

In the first experiments with sound the scientists only partially succeeded in dissipating fogs, although they had disappeared completely in the chamber. But the experiments have only begun. Scientists must still solve many problems in allied branches of science such as meteorology, physics, chemistry and other sciences.

In a year of two, possibly, generators exactly like these may be used to clear fogs from airports, drive thunderclouds away from stadiums during games, or artificially cause rainfall over the fields of collective farms. ("Laboratory in the Caucasus Mountains," by L. Agayan; Promyshlenno-Ekonomicheskaya Gazeta, 6 March 1960, page 4)

Meeting of the Second All-Union Conference on Problems of Aeroclimatology

The Second All-Union Conference on Problems of Aeroclimatology was held in Moscow in November 1959. Participating in the conference were 26 scientific-research and operational subdivisions of the Hydrometeorological Service and 29 institutions of various departments. The total participation was 223 individuals.

The goal of the conference was to sum up the results of the development of aeroclimatic research in the USSR during the period that has elapsed since the First All-Union Conference on Aeroclimatology (October 1954) and to determine the main directions and tasks of future research in the field of climatology.

The deputy chief of the Main Administration of the Hydrometeorological Service of the USSR (GUGMS), K. T. Logvinov, pronounced the opening words at the beginning of the conference.

During the course of the conference 27 scientific reports on various problems of aeroclimatology were delivered and discussed.

The director of the Scientific Research Institute on Aeroclimatology (NIIAK), P. K. Yevseyev, summed up the main results of work on aeroclimatology accomplished in the USSR; he also characterized the status of the problem abroad. He noted that during the last 5 years there have been new attainments in the field of Soviet aeroclimatology, important both for an understanding of the processes of circulation in the atmosphere and for the solution of various problems. In addition Yevseyev pointed out that aeroclimatology is lagging behind the growing demands of the national economy of the country.

The conference devoted a great amount of attention to the problem of the distribution, over a period of years, of the principal meteorological elements in the free atmosphere over all of the Northern Hemisphere, especially over the territory of the USSR.

In characterizing the temperature field over the Northern Hemisphere, I. V. Khanevskaya (NIIAK) noted that in the winter the most active center of the cold polar region is situated over Eastern Siberia and that the thermal interaction of the oceans and continents (especially Eurasia) extends through a considerable thickness of the troposphere. Khanevskaya pointed out the presence in winter of an intensive region of heat in the stratosphere in the northern part of the Pacific Ocean.

V. R. Dubentsov of the Central Weather Institute (TsIP) described the temperature, geopotential and wind to the 10 mb level for January 1958 and July 1957. Debentsov noted that there is a region of strong westerly winds in the stratosphere over the polar regions in the winter.

L. G. Zastavenko (NIIAK) reported on the mean geopotential field. She emphasized that the Icelandic and Aleutian lows, in the form of independent centers, are only traceable to the 850 mb level. Seasonal regions of high pressure are very low and cannot be found at the 850 mb level.

I. G. Pchelko (TsIP) desribed the development of the summer anticyclone aloft on the basis of IGY data. He noted that the summer stratospheric anticyclone arises over the polar regions in May, extending to the temperate latitudes by July.

Wind distribution over the Northern Hemisphere, the subject of a paper by S. I. Dunayeva (NIIAK), supplemented our general ideas about the planetary circulation of the atmosphere.

A large group of reports was devoted to the distribution of the principal meteorological elements over the USSR. I. G. Guterman (NIIAK) examined the principal patterns of distribution of temperature, pressure and wind over the territory of the USSR, gave the value for the mean deviations for individual years and a description of interdiurnal changeability of the elements. In a second report he examined the characteristics of the wind at heights of 7-12 km pertinent to the tasks of servicing aviation.

M. V. Zavarina of the Main Geophysical Observatory (GGO) reported on the distribution of probabilities in zones of high turbulency, causing bumps in aircraft. On the basis of research she derived values for the turbulency by the indirect method, using the Richardson number.

With great satisfaction reports were heard and discussed which dealt with aeroclimatic descriptions of individual regions of the USSR.

N. F. Gol'mgol'ts of the Kazakh Scientific Research Hydrometeorological Institute (Kaz. NIGMI) reviewed the aeroclimatic characteristics of Kazakhstan, based on a program of aeroclimatic descriptions. In another report he examined the recurrence of forms of cloudiness in association with various meteorological phenomena.

A communication relative to the regime of the free atmosphere over Central Asia was made by S. N. Ivanov of the Central Asiatic Scientific Research Hydrometeorological Institute (Cr.-Az. NIGMI), which demonstrated the influence of relief on the distribution of temperature and wind.

In the reports presented by L. A. Gavrilova and V. I. Knyazeva, scientific workers at the Arctic and Antarctic Scientific Research Institute (AANII), statistical data were given on the structure of anticyclones and cyclones over the Arctic. Gavrilova pointed out the frequent circulation of heat in the Arctic stratosphere in winter.

Several reports were devoted to the characteristics of the tropopause and the near-surface layer. M. A. Zolatarev of the Central Aerological Observatory (TsAO) showed, by means of vertical cross sections of the atmosphere, that the determination of the tropopause on the basis of conventional criteria is obviously inadequate and that in this case it is necessary to take synoptic conditions into consideration. I. F. Kvartskheliya of the Tiflis Scientific Research Hydrometeorlogical Institute (Tbil. NIGMI) expressed a singular point of view in his report. He considers that in the presence of a multilayered tropopause over the southern part of the USSR the principal one is the upper, tropical tropopause. The lower layer of the multilayer tropopause he relates to fronts.

F. N. Stel'makh (NIIAK) discussed at length the characteristics of interdiurnal changeability of the height and temperature of the lower boundary of the tropopause over the various regions of the USSR.

The aeroclimatology of the boundary layer was the subject of reports by F. A. Vorontsov (GGO) and N. A. Lazarova (GGO). In both reports it was emphasized that the aeroclimatological study of the boundary layer should begin by the determination of its height. Both authors determine the height of the boundary layer on the basis of the theoretical premises of D. L. Laykhtman.

Great attention was devoted to problems of getting the aeroclimatic characteristics for servicing aviation and also a method for processing individual elements.

I. G. Guterman demonstrated that the distribution of wind velocity in the free atmosphere is subordinate to the well-known Maxwell distribution law. The computations made by Guterman enable us to determine the probabilities of any values using only the mean value for a number of years.

G. Ya. Narovlyanskiy of the Air Force Academy (BBA) and S. V. Solonin of the Leningrad Hydrometeorological Institute (LGMI) reported on a method for computing equivalent wind and showed that it was possible to use mean aeroclimatic data for this purpose.

The report by I. N. Shpakovskiy of the NIIGAU (Main Ordnance Administration Scientific Research Institution?) was devoted to the establishment of minimum times for sounding on the basis of the character of temperature and wind variability in time.

L. A. Kazakov (LGMI) pointed to the possibility of computing a series of supplementary mean characteristics of the atmopsheric regime (transfer of masses, etc).

R. F. Usmanov (TsIP) demonstrated the advantage of using standard elevations for research on atmospheric processes instead of the levels of isobaric surfaces.

In the discussions developing after the reports, attention was devoted to the important role of modern computer technology in the conduct of aeroclimatic research. However, as a result of the slow implantation of mechanization in various subunits of the Hydrometeorological Service the scope of this research was recognized as still being inadequate. A well-known hindrance to the development of aeroclimatic research on the periphery is the absence of initial data of aerological observations for the whole territory of the USSR and foreign countries.

Those delivering papers or participating in the discussions pointed out the unsatisfactory status of the problem of introduction of radiational corrections in data supplied by radiosondes of various systems; this makes the generalization of data difficult. In particular there was pointed out the very great value of the radiation correction recommended by the Central Aerological Observatory for the radiosonde RZ-049.

The conference recognized that it is expedient to conduct additional aeroclimatic research along three principal lines. These directions are the following: 1) statistical research on the free atmosphere, 2) synoptic-climatic research and 3) specialized processing for the satisfactory fulfillment of the demands of the national economy.

The conference recommended that the publication of daily aerological data be initiated, together with the microfilming of data for past years. It was recommended that the reports and data of the conference be published in a special series. ("Second All-Union Conference on Problems of Aeroclimatology," by I. G. Guterman and I. V. Khanevskaya, Meteorologiya i Gidrologiya, No. 2, 1960, pages 60-61)

Report on the All-Union Conference on Atmospheric Ozone

In October 1959 the All-Union Conference on Atmospheric Ozone was held at the Physics Faculty of Moscow State University. It was sponsored by the Ministry of Higher and Intermediate Education (Specialized) of the USSR, the Main Directorate of the Hydrometeorological Service of the Council of Ministers of the USSR and the Academy of Sciences of the USSR.

The problem of atmospheric ozone has recently been attracting an ever greater number of researchers, especially in connection with the conduct of the International Geophysical Year. During this period there has been established an extensive ozonometric network, both in the USSR and abroad, and an immense amount of interesting data has been received.

Although atmospheric ozone is an independent object of study of the physics of the upper layer of the atmosphere, at the same time it is attracting ever greater attention in the fields of synoptic and dynamic meteorology due to its close connection with atmospheric circulation. In actuality, ozone, as a conservative constituent of the atmosphere below 25 km, participates in horizontal and vertical movements of air masses as a singular "tagged atom" in the atmosphere.

Ozone measurement requires detailed observations of the solar spectrum (ultraviolet, visible and infrared) and careful considerations of its dilution by aerosols. This connects the study of ozone with the principal tasks of atmospheric optics. Finally, the application of modern methods of research (including rockets) and processing (by electronic computers) has meant that both mathematicians and upper atmosphere specialists are involved in ozonometric work.

Hence it can be seen that the conference, originally meant for a narrow circle of specialists on atmospheric ozone, has attracted the attention of a wide circle of scientific workers of many fields of geophysics. This guaranteed a highly advanced and multisided discussion of the reports delivered at the conference.

Seventeen different organizations participated in the conference. Twentyone reports were delivored by representatives of all the establishments conducting research work on atmospheric ozone in the USSR. The reports presented covered three types of problems:

1) The method for investigation of the general content and vertical distribution of ozone, its temperature, etc.

2) The theory of formation, and changes in atmospheric ozone.

3) The connection between atmospheric ozone and meteorological parameters of the atmosphere and synoptic conditions.

A number of reports in the first division reflected the introduction of new and modern methods of ozonometry. Thus, L. A. Kudryavtsev (Central Aerological Observatory) reported some results of investigations of the vertical distribution of ozone with the assistance of rockets in 1959. A. S. Briayev (Central Aerological Observatory) reported on the new chemical method of determining ozone. R. G. Romanova reported on the determination of ozone from an aircraft, as reflected in several horizontal and vertical cross sections. Ye. S. Kuznetsov reported on methods of using electric computers for the computation of the vertical distribution of ozone.

Considerable attention was evoked by the method of "rotation" and the possibility of determination of the vertical distribution of ozone by this method. The keynote of the discussions in this division was the problem of the calculation of the aerosol component of the atmosphere in ozonometric research capable of giving either a selective or "grey" scattering of light.

K. Ya. Kondrat'yev reported on work being conducted at Leningrad State University on the study of the infrared spectrum of absorption of atmospheric ozone. R. S. Steblova reported on recent Soviet spectroscopic determinations of the temperature of the ozone layer.

Problems in the second division were the subject of reports by G. P. Gushchin—on the significance of turbulent mixing for seasonal and latitudinal variations of atmospheric ozone, by A. Kh. Khrgin—on the causes of the diurnal variation of atmospheric ozone in different regions of the globe, and by V. D. Reshetov, who proposed an original qualitative hypothesis concerning the formation of ozone in aqueous aerosols.

The study of the connection between atmospheric ozone and meteorological parameters of the atmosphere has great theoretical significance because a large part of the ozone is located in the stratosphere and at the same time variations of ozone depend on changes of meteorological elements essentially of tropospheric origin.

Reports pertinent to the third division show that the study of the relationship between atmospheric ozone and the weather is proceeding along the line of statistical processing of the results and the establishment of correlative connections, both on the basis of synoptic methods and comparison with atmospheric processes. In the reports of this division a connection was discovered between the ozone content and the position of the axis of the jet stream (T. P. Gushchin, Main Geophysical Observatory), as well as with the intensity of zonal and meridional circulation (G. I. Kuznetsov, Moscow State University), expressing itself in an increase in ozone to the north and a decrease to the south of the main frontal zone.

In respect to the geographical distribution of atmospheric ozone, T. U. Karimov (Arctic and Antarctic Scientific Research Institute) and T. S. Gol'm of the ANIO at Dikson (abbreviation not identified) reported on peculiarities of the seasonal and latitudinal variation in ozone content, based on the observation of our Arctic ozonometric stations, while B. Ye. Shneyerov of the Main Geophysical Observatory reported on observations of atmospheric ozone in Actarctica.

In contrast to established ideas, there has been discovered an asymmetry in the latitudinal distribution of the total content of ozone relative to the Pole; this is associated with the presence of a meridional gradient of atmospheric ozone over the continent (G. I. Kuznetsov, Moscow State University). In many of the reports presented there was noted the presence of a more or less close connection between ozone and certain other atmospheric paramters at different levels (in the presentations of of A. S. Britayev, Central Aerological Observatory; T. S. Gol'm, ANIO Dikson; R. G. Romanova, Main Geophysical Observatory and others). But in several regions we have not succeeded in establishing such a relationship (Sh. M. Chkhaidze, Abastuman Astronomical Observatory).

In the discussions the need was pointed out for the examination of higher levels (up to 25 mb) for the analysis of the hypothetical relationships between atmospheric ozone and temperature and the circulation of the atmosphere.

As a whole the conference demonstrated that at the present time there is an extensive network of stations and institutions in the USSR staffed by skilled scientific personnel and conducting systematic and multisided investigations of atmospheric ozone. The results of this work are of great importance for the study of the ozone layer and its connections with atmospheric processes.

The conference regarded it as expedient to establish an interdepartmental commission on atmospheric ozone for the planning and coordination of future ozonometric work in the USSR.

The conference by the adoption of a resolution recognized the need in 1960 for making a comparison of the types of ozonometric instruments used in the USSR. It was also noted that in connection with the growth of ozonometric work in the USSR it is desirable to conduct similar conferences every 2 or 3 years. Finally, a resolution was adopted relative to the publication of the works of the conference. ("The All-Union Conference on Atmospheric Ozone," by G. I. Kuznetsov, Meteorologiya i Gidrologiya, No. 2, 1960, pages 58-59)

The Future of Radiosonde Observations

The following is the full text of an article in the February 1960 issue of Meteorologiya i Gidrologiya:

The method of making radiosonde observations, widely used throughout the world, was devised thirty years ago in the USSR.

The first radiosonde in the history of science was released at the Pavlovskaya (Slutskaya) Aerological Observatory of the Main Geophysical Observatory near Leningrad on 30 January 1930; it was a triumphal accomplishment of the collective efforts of a group of aerologists, enthusiasts of the new technology, headed by the gifted Soviet scientist P. A. Molchanov.

We recall that the first successful ascent of a French radiosonde was not accomplished by the scientists of that country until six months after the beginning of Soviet radiosonding, German scientists required almost a year and a half to achieve this, while in the United States the decennial of radiosonding with their own apparatus was not reached until 1947.

In these days of striking advances in the field of automation and telemetry, by which we are successfully accomplishing the solution of even extraordinarily complex problems (the measurement of the pulse and blood pressure of a living being in cosmic space, the reception of photographs of the reverse side of the moon, etc.), it is becoming difficult to realize that it was only relatively recently that measurements by radio had never been made and the very idea of the possibility of such measurements came under the heading of scientific fantasy.

The release of the first radiosonde was the illustrious result of the research stage in work for the creation of such an instrument; this was followed by the no less important stage of development and perfection of the new method of aerological observations and its introduction into practical use.

In the years that followed a great many varieties of radiosondes were built in different countries; some of them are still in use at the present time. The first international comparison of radiosondes was made in 1950 at Payerne, Switzerland; a second comparison was made at the same place in 1956, with a large number of countries participating. The results of the comparative ascents of radiosondes of the different systems showed that their technical characteristics, with small deviations, can be expressed by the following mean norms.

1. Random errors in measurements: a) air temperature $\pm 1 \div 2^{\circ}$, b) air pressure $\pm 2.5 \div 5$ mb, c) humidity $\pm 8 \div 10\%$.

2. Speed of ascent 300-400 m/min.

3. Duration of ascent 50-100 minutes.

4. Weight of instrument 1.0 - 1.6 kg.

5. Time required for full processing of the results of radiosonde observations--90-120 minutes.

6. Inertia of data units: a) temperature--from 5 to 40-50 seconds, b) humidity--from 15-20 seconds to several minutes and even several dozen minutes (at temperatures of about -40° and below the inertia of the deformed receivers is measured in the hours, that is, they are practically inactive).

7. All radiosondes are characterized by systematic errors from the influence of solar radiation, at times increasing the results of measurements of air temperature, especially in the stratosphere, by $3-10^{\circ}$ and more.

From the first releases of radiosondes observations have been made with theodolites; this enables us to get supplementary data about winds aloft. The fact that such observations were limited by the range of visibility forced Molchanov to turn to short wave radio direction finding. By 1939 a tri-point system of radio direction-finding observations had been developed, enabling us to get wind data for heights above the clouds at any time of the day. However, errors in such radio-transmitted measurements were approximately ten times greater than errors associated with theodolite measurements. This, together with the complexity of organization of tri-point observations, detracted from the practical significance of short-wave radio direction finding.

Beginning in 1943 radar stations began to form part of the ground equipment of radio sounding points; these made it possible to make wind measurement simultaneously with radio sounding; this is done by using passive reflectors in the form of crimped segments of wire fastened to the radiosondes. Observations of this type were possible at an inclined distance of 15-25 km. A sharp increase in the distance of wind observations (up to 100 km and more) was achieved between 1950 and 1951 after the introduction of ultrashort wave direction-finding transmitters into radiosounding; these are more economical in power use than are shortwave transmitters, ensure the best reception of signals, and permit the reception of signals and precise direction finding by means of radar-type apparatus.

Beginning in 1955 technical progress in the field of radio sounding was once more accelerated by the vigorous development of radio electronics.

A great achievement during this period was the development of a system of radiosondes with transmitters-responders, highly automated ground receiving and recording apparatus, and computers for the processing of radiosonde data.

Progress in Soviet radiosonde work in this period was expressed not only in the development of new, more technically perfect instruments and ground equipment; there was also improvement in the envelopes, whose quality determines the ceiling to which sounding is possible.

Strictly speaking, the envelopes have remained as before, but their method of use has been improved by the introduction of a preflight processing of the latex by the vapors of such hydrocarbons as kerosene and gasoline. This simple measure has had an extremely appreciable effect: whereas before 1955 the mean height of sounding in the USSR had been 12-15 km, subsequent to the introduction of the preliminary processing of the envelopes the height of radiosonde ascents has increased sharply and now averages 20 to 22 km.

A continuing development of the radiosonde method is necessary for the solution of a number of problems which should be treated in greater detail.

Aviation is in need of systematic data on the state of the atmosphere to heights of 30-35 km, but presently only occasional radiosondes attain such altitudes.

The speed of ascent of radiosondes with the present type of envelopes cannot exceed 400 to 450 m/min due to the aerodynamic peculiarities of the soft envelope. This is because with a continuing increase in speed there are formed hollows or pockets in the envelope which markedly decrease the rate of ascent. An increase in the height of sounding can only be achieved by means of prolongation of ascent and this entails an increase in the weight of the batteries feeding the radiosonde transmitter. The result is a viscious circle because the great weight of the instrument would decrease the heights attainable by the radiosonde. The solution of this problem might be the use of the some new method of powering the radiosonde, for example, a change to the use of the energy of a radio beam emanating from a ground "power" apparatus. Up to now such a system has never been used, but in principal it is unquestionably feasible.

Moreover, with an increase in the height of ascent the amount of time involved in processing the radiosonde signals increases correspondingly; this makes inevitable a great time lapse between the initiation of sounding and the reception of its final result—telegrams to prognostic centers.

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Of course, any additional delay in the transmission of processed radiosonde data substantially decreases their value. A radical solution of this problem would be the creation of completely new radiosondes with accelerated action with inertialess transmitters carried aloft, for example, in small rockets.

It is expedient to use automatic computers for the rapid processing of radiosonde data. These computers enable us to get output data almost simultaneously with the input. In this case the final result could be received quickly after the termination of signal reception. By use of such radiosonde technology there would also be eliminated still another of its deficiencies, that is, that the higher an ordinary radiosonde rises, the farther it is carried in a horizontal direction; as a result, we usually get pronouncedly inclined cross sections of the atmosphere, rather than the vertical cross sections desired. This circumstance doubtlessly lessens the possibility of correct use of the results of sounding. This is because the true picture of the distribution of meteorological elements vertically over a given point cannot be drawn up on the basis of such data.

Finally, it is necessary to note that with an increase in the height of radiosonde ascents it is necessary to have a radical improvement of the method of determining pressure. The relative accuracy of measurements of this element by aneroid capsules at altitudes exceeding 25 km, becomes completely unsatisfactory, because the value for pressure measured at great altitudes is commensurable with the value of absolute accidental and systematic errors of aneroid data units.

We have developed a system of precise measurements of the angular coordinates and inclined distance of a drifting radiosonde that in combination with extremely precise data for air temperature at all altitudes will enable us to compute pressure by the barometric formula with sufficient accuracy.

However, complete solution of the problem of highly accurate measurement of pressure is not provided by this method; this is because the high accuracy of short-range radar measurements drops to unsatisfactory levels at greater distances. Apparently the abolition of the barometric capsule with all its associated errors is theoretically possible provided the height of the radiosonde is determined by the principle of the aircraft radioaltimeter.

Present-day radiosounding is essentially based on the use of meteorological data units of the deformation type; these are characterized by many deficiencies. Only the first halting steps have been taken towards the use of data units of a more modern type--in the form of the use of thermistors and temperature-sensitive condensers for the measurement of temperature, but these gauges still possess great inertia and are subject to considerable influences from radiation.

No radiation method has yet been found for the measurement of air humidity. Certain hygrometers with conducting membranes of solutions of lithium chloride and other hygroscopic salts, with layers of carbon particles, preheated hygrometers, hygrometers with rolled hair, with animal membranes, dew point hygrometers, etc., practically do not operate at temperatures below -40 or -50°.

Moreover, for the transmission of meteorological and other characteristics of the atmosphere it is necessary to incorporate reserve telemetric channels and coordinated data unit channels in the radiosonde to enable us to increase the complex of measured meteorological elements. At the level of present-day technology this problem is completely soluble. if we replace the primitive methods of telemetry now in use in radiosounding with the more modern methods based on the utilization of rapid-action electronic circuits.

The above-expressed aspirations in respect to the future development of the radiosonde method can be solved successfully in a short time if future work on the perfection of this method is carried on with the international cooperation of aerologists of different countries. There is no doubt that such cooperation by scientists would prove to be extremely productive and would facilitate the future development of meteorological science. ("Thirty Years of Radiosondes," by V. S. Khakhalin and V. A. Pobiyakho, Meteorologiya i Gidrologiya, No. 2, 1960, pages 45-47)

"Astronomical Research"

I had the opportunity of participating in compiling the first map of the far side of the moon which was recently published in the Soviet press. There can be no doubt that this map will be improved and augmented on the basis of new material which will be obtained with space rockets.

Taking into account that astronautics is still developing at a rapid rate in our country and the moon and the nearer planets are of great interest for future travelers who will land on their surfaces, our observatory in 1960 as before will devote its main attention to studying the physical conditions on the moon, Mars and Venus. This will give us the opportunity to collect new data on these heavenly bodies.

In 1960 the observatory will study the radio emission of the sun and the processes which take place in its atmosphere and greatly effect the electric and magnetic properties of our planet, the propagation of radio waves, etc. Khar'kov astronomers will be working on determining accurate time, on compiling star catalogs, and will study problems in the irregularity of the earth's rotation.

The equipment for astronomical research in the observatory is constantly increasing. In 1959 we acquired a number of instruments for observing the artificial earth satellites and for planetary research. This year we hope to obtain a large, planetary telescope which will be installed not far from Khar'kov. There work will be expanded on studying the physical conditions on planets and on observing the artificial space bodies.

The increase in the apparatus of the observatory and the expansion of work in the different areas of astronautics will make it possible in the near future on the basis of our institution to establish a planetary institute for more extensive research on the more important problems connected with the study of outer space.

In 1960 there will be published a number of scientific works prepared by members of the observatory. In addition to a major monograph on "Photographic Photometry of Mars with Light Filters in 1956" (by M. P. Barabashov and Candidate of the Physical and Mathematical Sciences I. K. Koval) there will be the "Reports of the Committee on Planet Research of the Academy of Sciences of the USSR" which will be published by the Khar'kov University Press.

Great enthusiasm will be a feature of the work of the Khar'kov astronomers who are making their contribution to the nationwide matter of developing communism in our country. /A photograph of the author accompanies the article./ ("Astronomical Research," by M. P. Barabashov, director of the Astronomical Observatory of the Khar'kov University imeni Gor'kii, member of the Ukrainian Academy of Sciences, Nauka i Zhittga, No. 2, 1960, page 22).

List of Bulgarian Meteorological Stations

A list of the more important Bulgarian meteorological stations and their location as published in the Statistical Yearbook of the People's Republic of Bulgaria, 1959, is given below.

Meteorological Stations	Height Above Sea Level in Meters	Geographical Longitude East[1]	Geographical Latitude North
North Bulgaria			
Novo Selo--Vidinsko	38	22 47	44 10
Lom	33	23 15	43 49
Vratsa	309	23 32	42 12
Pleven	116	24 36	43 25
Gorna Oryakhovitsa	94	25 45	43 07

/Continued on page 32/

[1]According to Greenwich.

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Kolarovgrad	220	26 56	43 16
Ruse	46	25 58	43 51
Silistra	16	27 16	44 07
Varna	48	27 52	43 10
South Bulgaria			
Burgas	5	27 29	42 29
Yambol	143	26 31	42 29
Khaskovo	191	25 33	41 56
Kazanluk	380	25 24	42 37
Plovdiv	160	24 45	42 09
Southwest Bulgaria			
Sofia--Hydrometeorological Service	564	23 20	42 41
Kyustendil	520	22 41	42 17
Mount Stalin	2,925	23 35	42 12
Sandanski	190	23 17	41 34

(Statisticheski Godishnik Na Narodna Republika Bulgariya, 1959 /Statistical Yearbook of the People's Republic of Bulgaria, 1959/, page 8. Published by the Central Statistical Administration of the Council of Ministers, Sofia.)

"Sever-12" Personnel Leave for Arctic

The first group of workers for the new high-latitude expedition, "Sever-12," were flown from Leningrad into the Arctic on 15 March. ("In a Few Lines," Moscow, Pravda, 16 March 1960, page 6)

V. ARCTIC AND ANTARCTIC

Preparations for Spring Activities in the Arctic

The following is the full text of a 11 March 1960 article in Sovetskaya Aviatsiya.

The approach of the spring season is being felt in the Arctic. And although the intense cold continues to be severe, the long polar night has ended and the bright sun has already risen high above the horizon, bathing the limitless white snowy surfaces with the rays of springtime.

There is nothing to disrupt the stillness of the icebound Arctic seas, but sometimes, like the sound of an artillery shell, one can hear the cracking sound of the ice field as it breaks apart or the unexpected whistling of the wind as it strikes against the hummocky surface of the ice field.

But more and more frequently the hum of motors is being heard over the Arctic. Aircraft of the polar aviation service are making a far-reaching ice reconnaissance. This is the first sign of the approach of spring in the Arctic and with it the time for high-latitude expeditions.

This year the twelfth successive air expedition will move into the Central Polar Basin. More than 15 aircraft of various types will participate. But the chief plane to be used on the expedition will, as before, be the "work horse" aircraft, the "LI-2," mounted on skis, and also the "IL-14," which has performed well under expeditionary conditions.

The air detachment will replace the personnel at the drifting scientific-research station "Severnyy Polyus-8"; replace the personnel and deliver everything needed for the work and life of the new station personnel; in the Pacific sector of the Arctic basin it will organize a new drift station, the "Severnyy Polyus-9."

From the aircraft it is necessary to spot a solid floe for the "SP-9" on which the polar workers can boldly set out on their long drift through the Arctic Ocean, establish an airdrome on the ice, deliver hutments, equipment, foodstuffs, and the new station's personnel. In addition, the air detachment will set out radio beacons in the Arctic seas--automatic radio meteorological stations (a total of 15). This is also complicated business. The point is not to establish meteorological stations in places where there is a suitable ice floe for the landing of an aircraft, but in those places where the scientists require them.

The selection from the air of landing places on the drift ice, the process of landing on and takeoff from a floe of limited size, split by cracks and covered by hummocks in blindingly white surroundings, flight to the required points without radio beams to follow or ground points for orientation, is a difficult matter and requires from aircraft commanders and all crew members not only courage, hardiness, and experience, but genuine airmanship as well.

This was all taken into consideration when selecting personnel for the crews of the expedition's aircraft. The aviation detachment is headed by one of the most seasoned polar fliers--Petr Pavlovich Moskalenko--a participant on almost all high-latitude expeditions. Also included in the expedition are the experienced polar fliers M. Vasil'yev, A. Yefimov, V. Mal'kov, and S. Petrov.

Another participant is the celebrated polar flier V. I. Maslennikov, Hero of the Soviet Union, who has personally found the majority of the floes under the drift stations. Vitaliy Ivanovich has been flying over the Arctic expanses for a quarter century, and there is not the remotest corner or small islet there which he has not visited. More than once he found himself in a "fix," but his great experience and knowledge assisted him in finding the proper solution.

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It is possible to say much on the good side about other participants in the expedition: the aircraft commander A. A. Lebedev, the airmen F. Utyashev, I. Pitonov, Ya. Sokolov, N. Stepanov, and others.

Experienced navigators are participating on the expedition. Among them is B. Brodkin, a participant in the search for Belgian polar workers in Antarctica, Ye. Rybakov and B. Ivanov, great specialists at ice reconnaissance, and also many other navigators, aircraft mechanics, aircraft radiomen, engineers and technicians.

Presently the preparation of aviation equipment and the training of the air detachment are being completed. In the second half of March the planes will be off to the Arctic. ("To the Center of the Arctic," by M. Filipenin, Sovetskaya Aviatsiya, 11 March 1960, page 4)

The Ob' Arrives at Peter I Island

The Soviet expeditionary ship Ob' has completed a scientific voyage around Antarctica; it has traveled many thousands of miles in the waters of the high latitudes. Enroute the ship encountered the whaling flotillas "Sovetskaya Ukraina" and "Slava."

After continuing its eastern voyage the Ob' approached the little island named for Peter I, "lost" in the Bellingshausen Sea, that had been discovered in 1821 by participants in a Russian expedition.

For over a hundred years the island remained unvisited. In the first half of the present century many expeditionary ships tried to approach it, but the ice and gale force winds prevented the explorers from landing on shore. Only in 1929 was a landing made by seamen from a Norwegian whaling vessel.

The diesel-electric ship Ob' circumnavigated the island. At this time a photographic survey was made of the shores, depths were measured and the waters washing the island were investigated. It is reported from the Ob' that the size of the island is far smaller than is shown on Norwegian maps compiled at an earlier date. The island is an ice-covered volcano with three peaks, not just one, as believed formerly. The highest point is 1,200 m above sea level. The height of the craggy shores is as much as 200 meters.

The exploration of the region adjoining Peter I Island by the expedition on the Ob' is of great scientific interest. ("The Ob' at Peter I Island," Pravda, 13 March 1960, page 6)

Scientists Heading Poleward for Spring Arctic Research

This is a full Izvestiya report of 17 March 1960:

Yesterday the first three planes of the polar service of the Civil Air Fleet took off from an airdrome near Moscow for flight to the Arctic. They are part of the aviation detachment under the command of the experienced pilot P. Moskalenko and will participate in exploration of the Central Polar Basin. The heavy 4-motor Tupolev aircraft was piloted by the famed polar airman V. Perov, the aircraft "IL-14" was commanded by V. Veselovskiy, and the "LI-2," by the pilot N. Vakhonin.

On the morning of the same day "Il-14" aircraft took off from Leningrad; they were commanded by the airmen A. Il'in and A. Yefimov. They will deliver the first group of scientists, and part of the freight and equipment of the expedition "Sever-12," to intial Arctic bases.

The aviation detachment of the expedition, consisting of more than 15 aircraft, will have grave responsibilities. The airmen are to accomplish the replacement of the personnel of the drift station "Severnyy Polyus-8," supply its new personnel with all they need until autumn and establish a new drift station, "Severnyy Polyus-9." In addition, the two aircraft, equipped with ski-type under-carriages, will set out automatic radio-meteorological stations and radio beacons for determination of the movement of ice along the course of the Great Northern Sea Route.

All personnel of the expedition have considerable experience in the Arctic and have been splendidly trained. Victor Perov is participating in flights to the Pole. With the group of scientists aboard his aircraft he is first making a thorough circumpolar ice reconnaissance, and then will take part in transporting freight and fuel to the "SP-8" and "SP-9."

The new scientific personnel of both drift stations, in full strength, will depart from Leningrad by plane by 25 March. ("To the North Pole," Izvestiya, 17 March 1960, page 4)

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